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DRILLING DELAMINATION STUDY ON CARBON REINFORCED LAMINATES – TOOL AND FEED RATE EFFECTS

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Summary. *The characteristics of carbon fibre reinforced laminates had widened their use, from aerospace to domestic appliances. A common characteristic is the need of drilling for assembly purposes. It is known that a drilling process that reduces the drill thrust force can decrease the risk of delamination. In this work, three combinations of the drilling process are compared: tool diameter, tool geometry and feed rate. The parameters evaluated include: thrust force, delamination extension and mechanical strength. This work shows that a proper combination of drilling parameters can contribute to reduce the delamination damage.*

1 INTRODUCTION

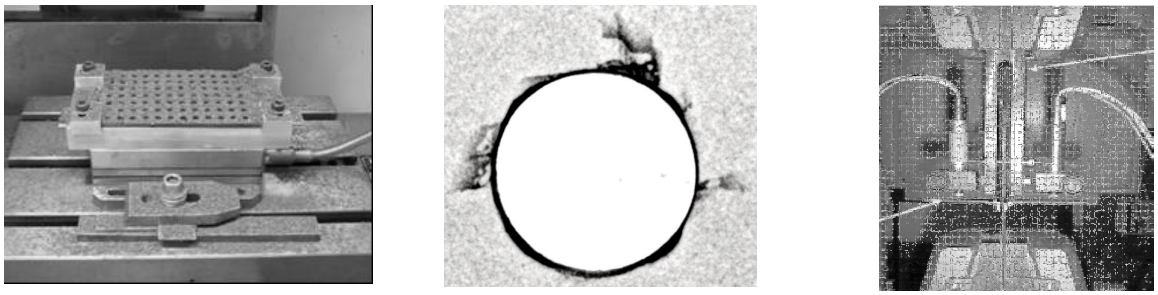
At the beginning of the 21st century, composites are one of the most promising groups of materials. Their main characteristics, as low density and high strength to weight ratio, turn composites into ideal solution when high stiffness and high specific strength are demanded. In fact, the importance and usage of composite materials have been growing in latest years, which can be confirmed by verifying their intensive use in the new Airbus A380 or Boeing 787 airplanes. Moreover, one can now find composite materials not only in the aeronautical field, but also in other industries, particularly when low weight and good mechanical characteristics should be combined.

Although composite parts are produced to near-net shape, finishing operations like drilling,

in order to allow the assembly of parts, are usually required. It is known that these operations can be carried out with conventional tools and machining equipments with suitable adaptations. However, due to the inhomogeneity of composite materials, drilling operations can cause severe damages. The most visible evidence of these damages is the existence of an edge around the machined hole, namely at the exit side of the drill. The more common referred damages in composite materials due to drilling operations are push-down delamination, fibre-pull-out and thermal damages [1].

In this work, the effect of three factors on the drilling process of carbon reinforced epoxy plates is studied: tool diameter, tool geometry and feed rate.

The set of parameters adopted in this evaluation includes: the thrust force monitoring during drilling; the delamination extension measured from enhanced digital radiographies [2]; and the mechanical properties evaluated from testing the drilled coupons by bearing test and open-hole tensile test (Figure 1).



a) b) c)

Figure 1: a) Experimental setup; b) original radiography; c) bearing test.

From the evaluation here presented, one concludes that a proper combination of the factors involved in drilling operations, like tool diameter, drill geometry and cutting parameters, can lead to the reduction of delamination damage and, therefore, to the enhancement of the mechanical properties of carbon fibre reinforced laminates in complex structures.

REFERENCES

[1] C. W. Wern; M. Ramulu, A. Schukla: Investigation of Stresses in the Orthogonal Cutting of Fiber-Reinforced Plastics, Experimental Mechanics, 36, 33-41 (1994).

[2] V. H. C. de Albuquerque, J. M. R. S. Tavares, L. M. P. Durão: Evaluation of Delamination Damage on Composite Plates Using an Artificial Neural Network for the Radiographic Image Analysis, Journal of Composite Materials, 44, 1139-1159 (2010).